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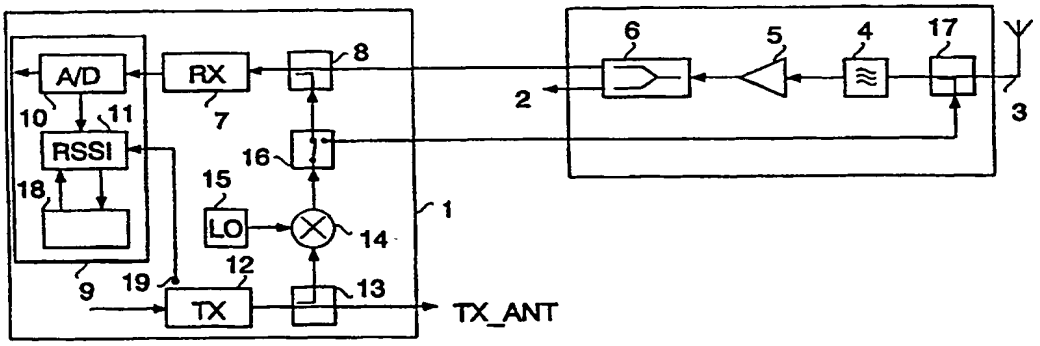

(57) Abstract

The present invention relates to a method for measuring gain variations of a distribution amplifier (5) at a base station of a cellular system and for eliminating their effect, the base station comprising an antenna unit (3) and at least one receiver (7) for receiving signals transmitted by radio transmitters currently located in the radio coverage area of the base station. In order to determine the signal level of the received signals, the actual gain of the distribution amplifier (5) is measured; the value representing the actual gain is stored in a memory means (18); and, during the normal traffic use of the base station, the value stored in the memory means (18) is used for eliminating the effect of gain variations of the distribution amplifier. The invention further relates to a base station at which the method of the invention is applicable.

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Method for eliminating the effect of gain variations of a distribution amplifier at a base station

The present invention relates to a method for measuring gain variations of a distribution amplifier at a base station of a cellular system and for eliminating their effect during the normal traffic use of the base station, the base station comprising an antenna unit and at least one receiver for receiving signals transmitted by radio transmitters currently located in the radio coverage area of the base station. The invention further relates to a base station of a cellular system, comprising an antenna unit, a distribution amplifier and at least one receiver for receiving signals transmitted by radio transmitters currently located in the radio coverage area of the base station.

Gain variation refers in this context to the deviation of the actual gain of the amplifier from the nominal value of the amplifier. Such gain variation is typically about ± 3 dB for the distribution amplifier of a base station, due to the wide frequency range and temperature variations, the total gain of the distribution amplifier being for instance 30 - 35 dB. As regards the operation of a cellular system, variations this wide are nevertheless harmful because for example GSM requires that the base station should continuously measure the strength of received signals during normal traffic use. This is done by means of so-called RSSI calculations (Received Signal Strength Indication), whereby the signal level of a received signal is calculated on the basis of a signal obtained from the output of the base-station receiver. It is apparent that the measured RSSI value deviates

significantly from the actual one if the gain variation of the distribution amplifier is as wide as ± 3 dB, and the nominal value of the gain of the distribution amplifier is used in the calculations.

It is nevertheless important that the RSSI value should be calculated as accurately as possible, because wide deviations in the RSSI value cause the base station to perform unnecessary handovers, as it assumes that the audibility of the radio transmitter is better via another base station or transceiver unit and thus that the radio transmitter has moved to another sector or cell. An erroneous RSSI value also causes problems for instance with automatic gain control.

The object of the present invention is to remove the problem mentioned above and to provide a method by which the effect of gain variations of a distribution amplifier at a base station can be eliminated. These objects are achieved with the method of the invention, characterized in that the actual gain of the distribution amplifier is measured for signals of different frequencies and at different temperatures; values representing the actual gain are stored in a memory means; and, during the normal traffic use of the base station, the value stored in the memory means which corresponds to the utilized frequency and the current temperature is used for eliminating the effect of gain variations of the distribution amplifier.

The invention further relates to a base station at which the method of the invention is applicable. The base station of the invention is characterized in that the base station comprises means for measuring the actual gain of the distribution amplifier of the base station, a memory means for storing the value representing the actual gain of the distribution amplifier, and correction means for eliminating the

effect of gain variations of the distribution amplifier of the base station by means of the value stored in the memory means, in determining the signal level of the received signal.

The invention is based on the idea that the base station is provided with means by which it can measure the actual gain of the distribution amplifier. When this actual value is compared to the nominal gain of the distribution amplifier, which is constant, a correction factor is produced, which is taken into account in the RSSI calculation carried out during the normal traffic use of the base station. The measurement of the actual gain of the distribution amplifier is carried out preferably by a test performed in connection with the initialization of the base station, but it is also possible to carry out this measurement during the normal traffic use of the base station, in which case a frequency channel with no traffic at that particular moment is used. Thus it is possible to change the correction factor to correspond to the changed conditions, for instance in order to take into account changes of temperature. The most important advantages of the method and the base station of the invention thus reside in the significant improvement in the accuracy of the RSSI calculation, whereby operations depending on said calculations, such as handover operations (between different sectors or different cells), are rendered more reliable.

In a preferred embodiment of the method of the invention, several correction factors are determined for the distribution amplifier of the base station, each of which corresponds to a certain temperature and frequency channel. These correction factors are then stored in a memory means at the base station, from which they can

be read during the normal traffic use of the base station.

The other preferred embodiments of the method and the base station of the invention are disclosed in the appended dependent claims 2 - 4 and 6 - 7.

In the following, the invention will be described in greater detail by means of a preferred embodiment with reference to the accompanying drawings, in which

Figure 1 shows a preferred embodiment of the base station of the invention, and

Figure 2 shows an example of a correction factor table stored in the memory means of the base station.

Figure 1 shows a preferred embodiment of the base station of the invention. The base station in Figure 1 is a GSM base station comprising a transceiver unit 1 and an antenna unit 3, by which the base station can receive radio signals transmitted by radio transmitters. The structure and operation of GSM are described for instance in "The GSM System for Mobile Communications", M. Mouly & M-B Pautet, Palaiseau, France, 1992, ISBN: 2-9507190-0-7, wherefore they are not further described here.

Signals received by the antenna unit 3 are passed via a filter 4 to a distribution amplifier 5. The output of the distribution amplifier 5 is connected to a branching unit 6, by which the received signals are branched and passed to the receivers of the transceiver units 1. The arrow at reference numeral 2 indicates a point from which a signal can be applied from the branching unit 6 to the other receivers at the base station, provided that there are more than one receivers at the base station. The signals transmitted by a

transmitter 12 are applied to a transmitting antenna TX_ANT of the base station via an interface.

The output of a receiver 7 is connected to an analog-to-digital converter 10 arranged in a baseband section 9. The signal obtained from the A/D converter 10 is applied to a calculator 11, which calculates the RSSI value representing the signal level of the signal received by the antenna unit 3. The calculator 11 preferably obtains the temperature data of the base station from the transmitter 12 by means of a sensor 19.

In order to eliminate the effect of gain variations of the distribution amplifier 5, the variations being typically about ± 3 dB when the total gain of the distribution amplifier is for instance 30 - 35 dB, the transceiver unit 1 of the base station shown in Figure 1 comprises a test loop, by which gain variations of the distribution amplifier can be measured during a special test period. The produced test results are utilized in connection with the RSSI value calculation carried out during the normal traffic use of the base station in order to eliminate the effect of gain variations of the distribution amplifier 5.

The test loop comprises a directional coupler 13, which is connected to the output of the transmitter 12 and via which a transmit-frequency test signal transmitted from the transmitter 12 is applied to a mixer 14. The test signal is converted by the mixer 14 to one of the receive frequencies used by the base station by means of an oscillator 15 operative during the test. To the output of the mixer 14 is connected a RF switch 16, via which a receive-frequency signal is applied either via a directional coupler 8 to the input of the receiver 7 or, selectively, to the input of the filter 4 arranged in association with the distribution amplifier via a directional coupler 17. In the latter

case, the test signal propagates from the output of the filter 4 to the distribution amplifier 5, at which it is amplified before it is applied via the branching unit 6 to the input of the receiver 7. The output signal of the receiver 7 is applied to the A/D converter 10, which is arranged at the baseband section and the output of which is connected to the calculator 11, which calculates the RSSI value during the normal traffic use of the base station.

Gain variations of the distribution amplifier are measured by transmitting a first test signal by the transmitter 12 and applying it in the manner described above via the directional coupler 13, the mixer 14, the RF switch 16 and the directional coupler 8 to the input of the receiver 7. After this, the signal level of the test signal obtained from the output of the receiver 7 is measured by means of the calculator 11, to which the signal is applied via the A/D converter 10. Next, the same test signal is retransmitted by the transmitter 12. This second test signal is passed via the directional coupler 13, the mixer 14, the RF switch 16, the directional coupler 17 and the filter 4 to the distribution amplifier 5. The signal obtained from the output of the distribution amplifier 5 is conveyed in the manner described above via the receiver 7 to the calculator 11, at which the signal level of the test signal is measured. By comparing the measured signal level of the first and the second test signal, the actual gain of the distribution amplifier can be determined.

Since the gain of the distribution amplifier 5 varies with the temperature and the used frequency channels, the above-mentioned test is preferably carried out several times. Each test result is stored in the memory means 18 arranged in association with the

calculator 11, which allows the calculator 11 to utilize the measured values in the RSSI calculation carried out during the normal traffic use of the base station.

The values stored in the memory means 18 can also be utilized to compensate for the gain variations of the distribution amplifier by adjusting the gain (not shown in the figures) of the distribution amplifier 5 on the basis of the values stored in the memory means 18 so that the gain variations of the distribution amplifier 5 will be compensated for.

Figure 2 shows an example of a correction factor table stored in the memory means of the base station, the table being produced by utilizing the test loop described above. The table in Figure 2 stores data indicating how much the actual gain of the distribution amplifier differs from its nominal gain at different temperatures and at different frequencies. Thus, it is for instance apparent from Figure 2 that, at temperature T1 and when frequency channel f1 is used, the signal obtained from the output of the receiver has to be corrected by correction factor k, so that the RSSI value, i.e. the value representing the signal level of the received signal, can be calculated correctly by means of the calculator 11 shown in Figure 1.

It will be apparent that the preceding description and the figures relating to it are only intended to illustrate a preferred embodiment of the base station of the invention without restricting the invention. Consequently, it will be apparent that the method and the base station of the invention can also be utilized in a system other than GSM, even though the invention has been described above by way of an example in the context of GSM. The preferred embodiments of the method and the base station of the invention can vary within the appended claims.

Claims

1. A method for measuring gain variations of a distribution amplifier (5) at a base station of a cellular system and for eliminating their effect during the normal traffic use of the base station, the base station comprising an antenna unit (3) and at least one receiver (7) for receiving signals transmitted by radio transmitters currently located in the radio coverage area of the base station, c h a r a c t e r i z e d in that

the actual gain of the distribution amplifier (5) is measured for signals of different frequencies and at different temperatures,

values representing the actual gain are stored in a memory means (18), and

during the normal traffic use of the base station, the value stored in the memory means (18) which corresponds to the utilized frequency and the current temperature is used for eliminating the effect of gain variations of the distribution amplifier (5).

2. A method according to claim 1, c h a r - a c t e r i z e d in that the actual gain of the distribution amplifier (5) is measured by

applying a predetermined test signal to the input of the receiver (7),

measuring the signal level of the first reference signal obtained from the output of the receiver (7),

applying said predetermined test signal to the input of the distribution amplifier (5) of the base station, after which the signal obtained from the output of said distribution amplifier (5) is passed to the input of the receiver (7),

measuring the signal level of the second reference signal obtained from the output of the receiver (7),

calculating the actual gain of the distribution amplifier (5) by comparing the results measured from the first and the second reference signal.

3. A method according to any one of the preceding claims, c h a r a c t e r i z e d in that the value stored in the memory means (18) which corresponds to the current temperature and the used frequency is taken into account in the calculation of the signal level of the received signal, said calculation being carried out during the normal traffic use of the base station on the basis of the signal obtained from the output of the receiver (7).

4. A method according to claim 1 or 2, c h a r a c t e r i z e d in that during the normal traffic use of the base station, the signal obtained from the output of the receiver (7) is corrected by the value stored in the memory means (18) which corresponds to the current temperature and the used frequency.

5. A base station of a cellular system, comprising an antenna unit (3), a distribution amplifier (5) and at least one receiver (7) for receiving signals transmitted by radio transmitters currently located in the radio coverage area of the base station, c h a r a c t e r i z e d in that the base station comprises

means for measuring the actual gain of the distribution amplifier (5) of the base station,

a memory means (18) for storing the value representing the actual gain of the distribution amplifier, and

correction means (11) for eliminating the effect of gain variations of the distribution amplifier

(5) of the base station by means of the value stored in the memory means, in determining the signal level of the received signal.

6. A base station according to claim 5, c h a r a c t e r i z e d in that the means for measuring the actual gain of the distribution amplifier (5) comprise

mixing means (14, 15) for converting the test signal applied by the receiver (7) of the base station from a transmit frequency to a receive frequency,

a switching means (16) for passing the receive-frequency test signal applied by the mixing means (14, 15) selectively to the input of the base-station receiver (7) or to the input of the distribution amplifier (5) of the base station, the signal obtained from the output of the distribution amplifier being applied to the input of said base-station receiver (7), and

a measuring means (11) for measuring the signal level of the signal obtained from the output of the receiver (7) of the base station.

7. A base station according to claim 5 or 6, c h a r a c t e r i z e d in that the base station is a GSM base station.

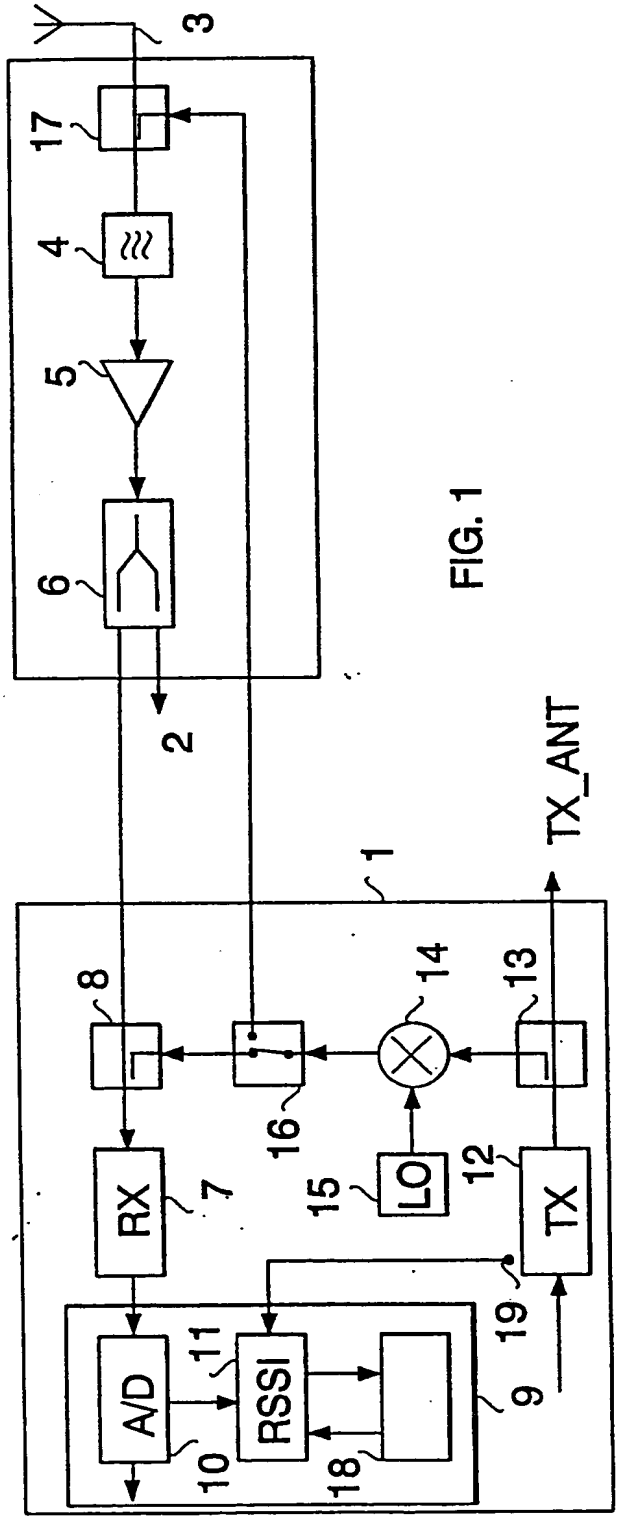
3
17
4
5
6
2
1
TX_ANT
8
14
13
16
RX
7
15
LO
12
TX
19
A/D
11
RSSI
9
10
18

FIG. 1

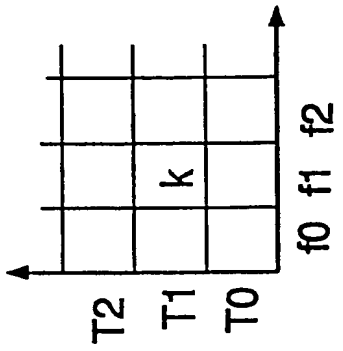
k
f0 f1 f2
T2 T1 T0

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 94/00428

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04B 7/005, H03J 3/04, H04Q 7/34
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04Q, H04B, H03J, H03G, H04B

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Patent Abstracts of Japan, Vol 15,No 438, E-1130, abstract of JP, A, 3-183203 (KOKUSAI ELECTRIC CO LTD), 9 August 1991 (09.08.91)	1,3-5
A	--	2,6
Y	Patent Abstracts of Japan, Vol 17,No 188, E-1349, abstract of JP, A, 4-336706 (MATSUSHITA ELECTRIC IND CO LTD), 24 November 1992 (24.11.92)	1,3-5
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Y	EP, A2, 0420508 (NOKIA MOBILE PHONES LTD), 25 Sept 1989 (25.09.89)	1,3,4,5
A	--	2,6

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO, A1, 8802200 (HARRIS CORPORATION), 24 March 1988 (24.03.88), figure 3, abstract --	1,5
A	EP, A2, 0481524 (NEC CORPORATION), 22 April 1992 (22.04.92), abstract -- ---	7

INTERNATIONAL SEARCH REPORT

Information on patent family members

31/12/94

International application No.
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A2- 0420508	25/09/89	US-A- 5313656	17/05/94
WO-A1- 8802200	24/03/88	NONE	
EP-A2- 0481524	22/04/92	AU-B- 643922	25/11/93
		AU-A- 8605091	30/04/92
		JP-A- 5022159	29/01/93
		US-A- 5196806	23/03/93